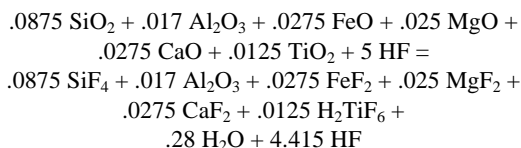


LUNAR OXYGEN PRODUCTION BY ELECTROLYSIS OF HYDROFLUORIC ACID LEACHATES OF LUNAR MARE SOILS. Bill Agosto, 2300 Buchta Road, Ste. 301, Angleton, TX 77515, 409/848-1855.

Recent interpretations of Clementine data, that suggest the presence of water ice at the lunar south pole, increase the prospects for extraction of lunar industrial metals and oxygen by methods of aqueous leaching. In particular, the work of Agosto and Yun [1] on aqueous hydrofluoric acid leaching of lunar soil simulants indicates that dissolution of lunar soils in high concentration HF acid is likely to yield a leachate enriched in iron and titanium and depleted in silicon, calcium, magnesium, and aluminum. Accordingly, such a leachate may be an excellent electrolyte for aqueous electrolytic plating of iron and evolution of oxygen from lunar soils at room temperature and atmospheric pressure.

For an average Apollo 11 mare regolith wt% composition (2) of: SiO₂ (42.04); Al₂O₃ (13.92); FeO (15.74); MgO (7.90); CaO (12.01); Na₂O (0.44); K₂O (0.14); TiO₂ (7.48); MnO (.21), and Cr₂O₃ (0.30) we assume, based on (1), the following reaction of 12.5 grams of feedstock in 100 ml of anhydrous HF taking into account only the major components, Si, Al, Fe, Mg, Ca, and Ti.



In a steel reaction vessel (Fig. 1) which is inert to high concentration HF (>70%) about a quarter mole of water is generated if the reaction goes to completion with vigorous stirring and active cooling, as shown, to prevent water vaporization and excessive over-pressure. Final pressure of volatilized SiF₄ and HF is approximately 6 atmospheres at 20C in a reactor volume of 1/2 liter. SiF₄ and HF vapor are vented to the NaF trap shown where they can be quantitatively absorbed for later recovery to reestablish a pressure of one atmosphere in the reactor.

At reaction completion, the electrolyte is a solution of ferrous and titanium fluorides in 95% HF which has a conductivity of 0.25 mho/cm, the same as for iron fluoroborate electrolytes that make very efficient iron plating baths [3]. The water vapor pressure over 95% HF at 20C is negligible [3]. Accordingly generated water will remain in the liquid where it can be completely electrolyzed.

Theoretically [3], 21 Wh of electrical energy are required to generate the 0.28 moles of hydrogen and 0.14 moles of oxygen available from the reaction. Accordingly, 4.5 grams of oxygen can be generated with 42 Wh at an electrolytic efficiency of 50%.

The hydrogen formed can be absorbed by a palladium cathode at the base of the reactor where iron metal also plates out. Electrodes should present no special problems as long as feedstock and reagent flows maintain the HF concentration

above 70%. Oxygen could evolve from a steel screen anode just below the liquid surface. Given ample time, gaseous, liquid, and solid phases should separate in lunar gravity.

Three liters of oxygen are generated in less than an hour with 50 watts of power in the above system and can be purified by cycling through the NaF cartridge to remove gaseous fluorides.

Fluoride values as well as all the major metals and silicon can be quantitatively recovered from cell residues and the NaF cartridge [4]. In addition, hydrogen and metallic lunar iron are available at the cathode while residue solids may be a suitable Hall process electrolyte for aluminum metal production.

HF ELECTROLYTIC CELL
FOR LUNAR OXYGEN PRODUCTION

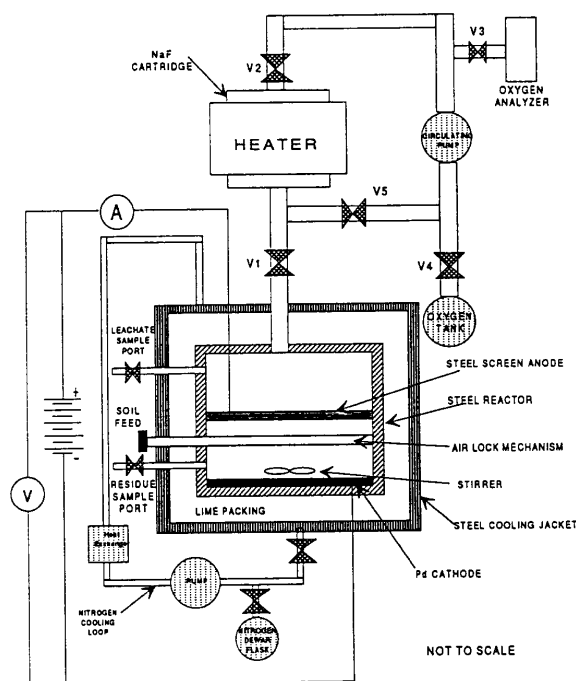


Figure 1

References: [1] Agosto W. N. (1989) Final Report, NASA/JSC Contract T-9720P. [2] Glass, B. P. (1982) *Introduction to Planetary Geology*, Cambridge U. Press, p.215. [3]. Kirk-Othmer (1978-1984) *Encyclopedia of Chemical Technology*, V 10, John Wiley and Sons. [4]. Agosto W. N. (1992) *Proceedings of Space 92*, American Society of Civil Engineers.